CMS/LHC Report

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Fermilab - CMS Center

All Experimenters' Meeting

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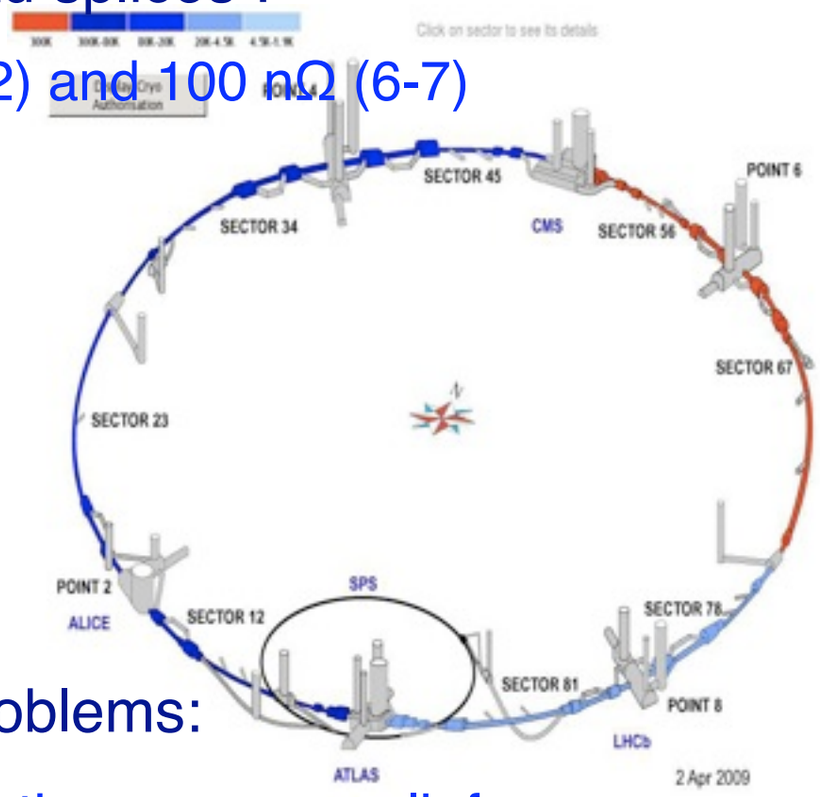
Outline:

- LHC Status
- CMS Status and Global Runs with Cosmics
- HCAL Upgrade : Silicon Photomultipliers

LHC : Current Status

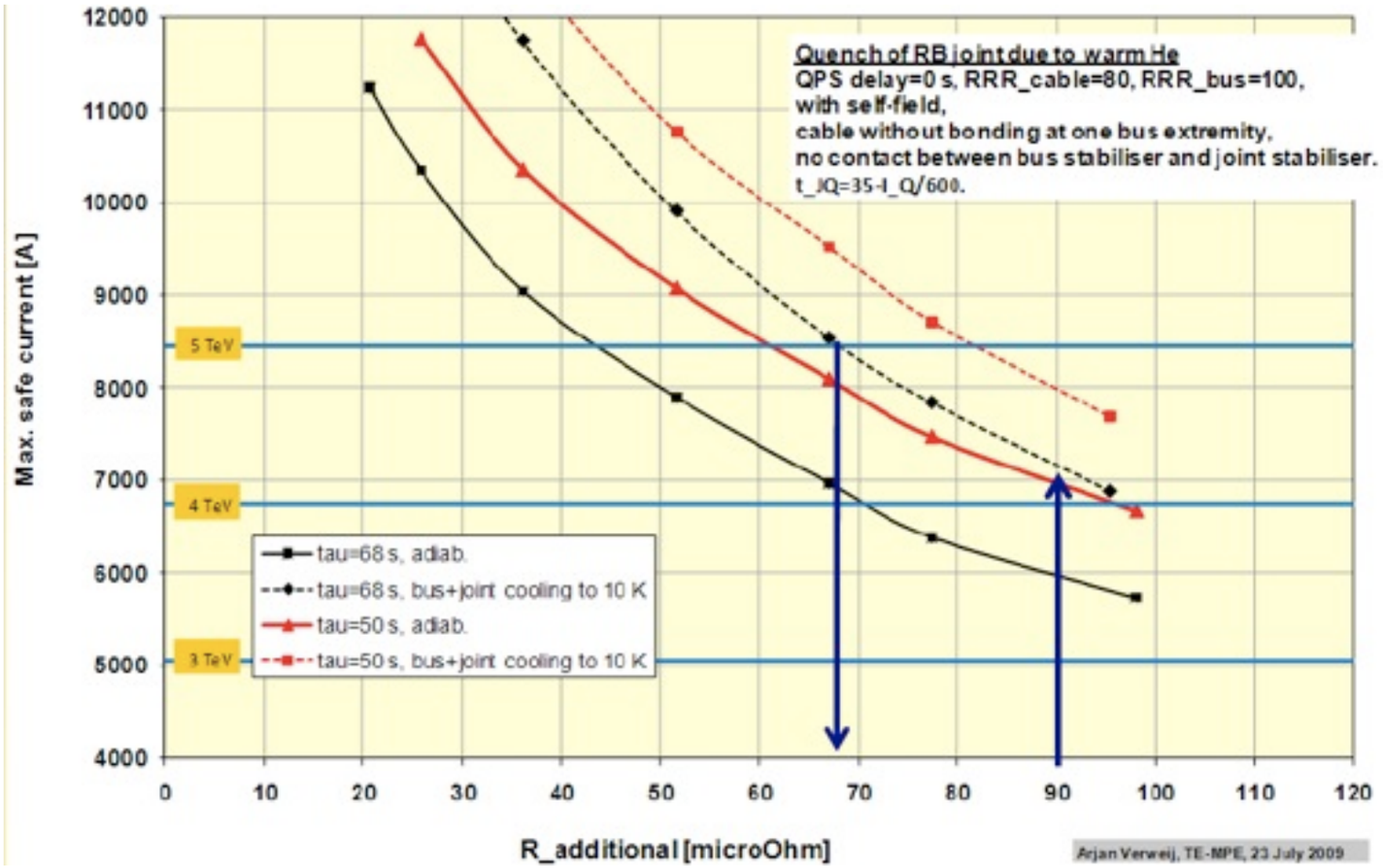
- There have been major upgrades of the quench protection system
  - Protection of all main quadrupoles and dipoles
- Massive measurement campaign to identify and repair bad splices :
  - Two bad cases found and repaired in 6 sectors: 50 nΩ (1-2) and 100 nΩ (6-7)
  - Two sectors still to be measured cold (4-5, 3-4)



- Copper Stabilizer problems:
  - 10 dipole and 10 quadrupole joints are repaired
  - sectors 7-8 and 8-1 are still to be measured
  - a lot of efforts in modeling the problem
- Measures taken to mitigate collateral effects in case of problems:
  - Additional release valves (“DN200”) installed to improve the pressure relief system (to eventually cope with maximum He flow of 40 kg/s in the arcs)
  - Reinforcement of the quadrupole supports (Arc quadrupoles, Semi-stand alone magnets ...)
  - Energy extraction times lowered (Faster discharge of the energy from circuits ...)

LHC Initial Operations

- Simulations show that resistances of 120 micro-ohm are safe from thermal runaway under conservative assumed conditions of worst case conditions for the copper quality and no cooling to the copper stabilizer from the gaseous helium



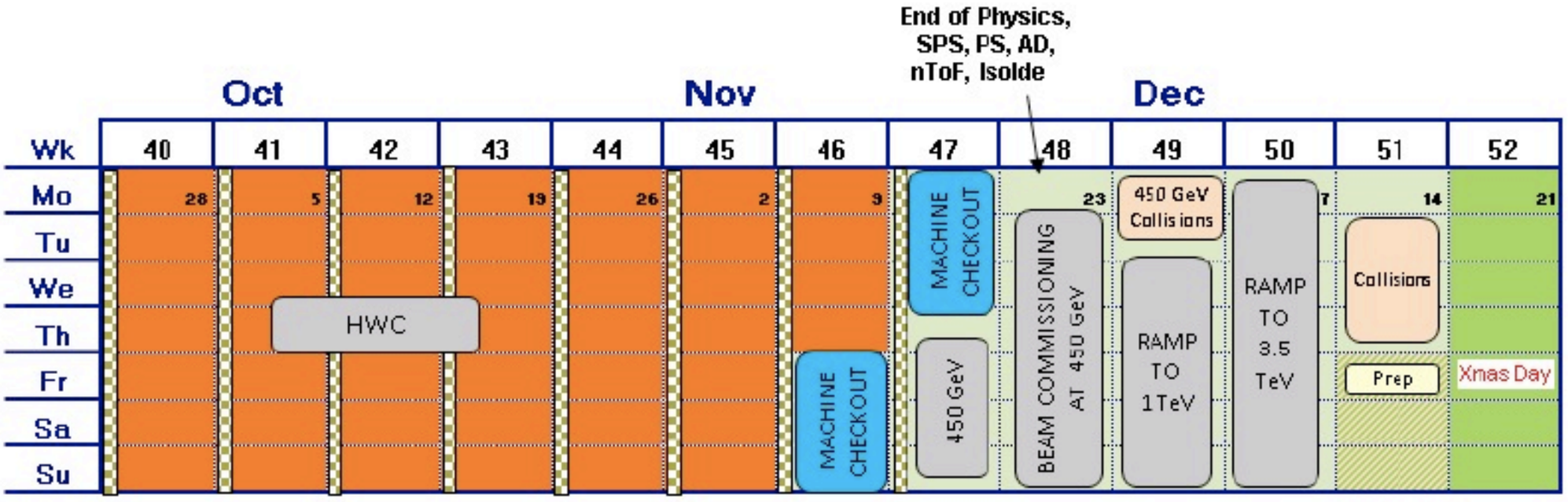
Worst case if quench happens in gaseous He environment

Decision : Operation initially at 3.5 TeV

(energy extraction time of 50 s) with a safety factor of more than 2 for the worst stabilizers.

Ramp up the energy to 4-5 TeV

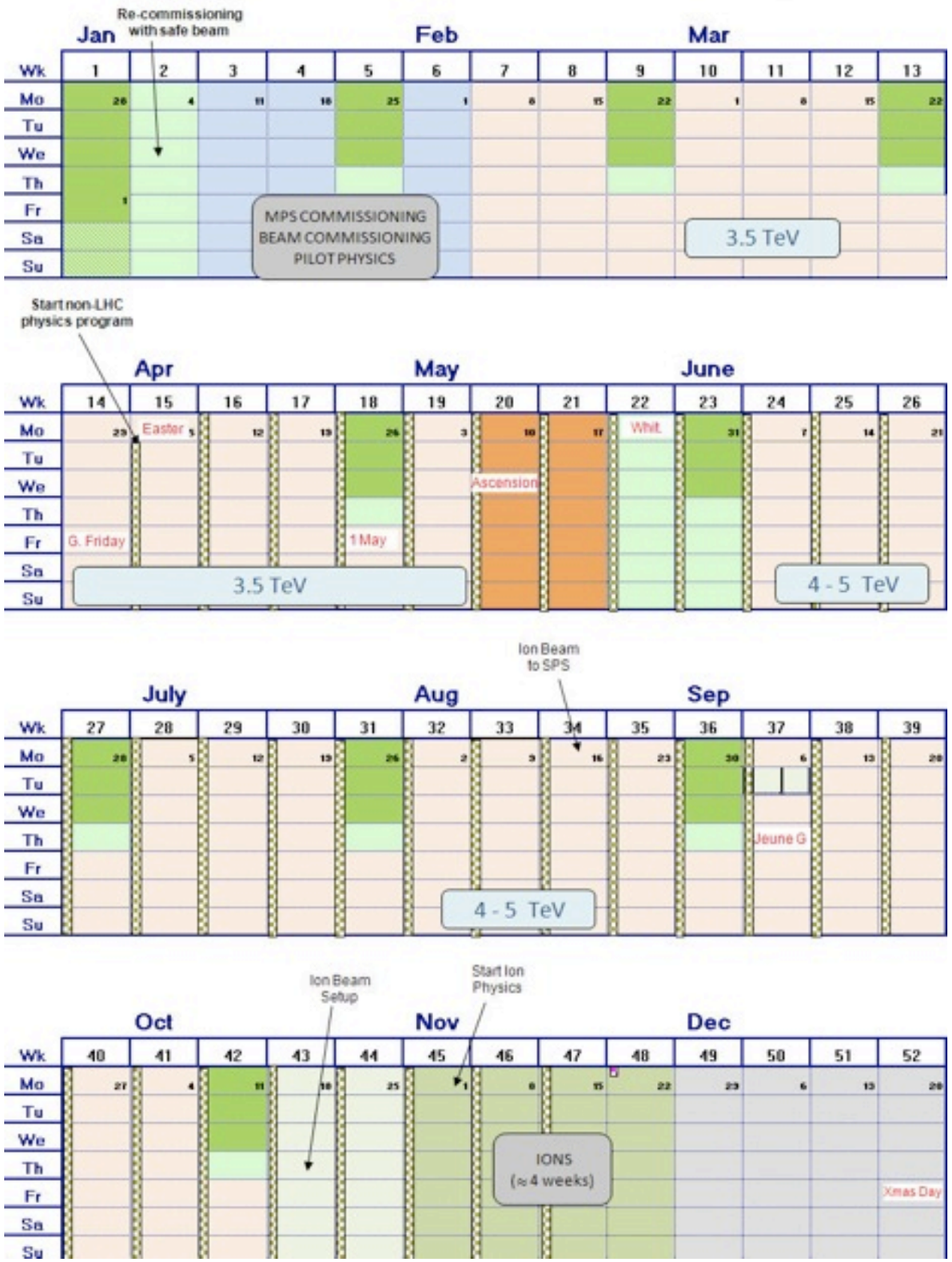
LHC 2009 : First Beam in Mid-November



Hardware Commissioning	October 2009
Essential 450 GeV Commissioning	Week 47-48 (Nov 16-23 & 24-29)
450 GeV Collisions & Ramp to 1 TeV	Week 49 (Nov 24 - Dec 06)
Ramp to 3.5 TeV	Week 50 (Dec 07 - Dec 14)
Collisions at 3.5 TeV	Week 51 (Dec 14 - Dec 20)

Stop LHC with beam ~19th December 2009, restart ~ 4th January 2010

LHC 2010 – Very Draft



2009

- 1 month commissioning

2010

- 1 month pilot & commissioning
- 3 month 3.5 TeV
- 1 month step-up
- 5 month 4 - 5 TeV
- 1 month ions

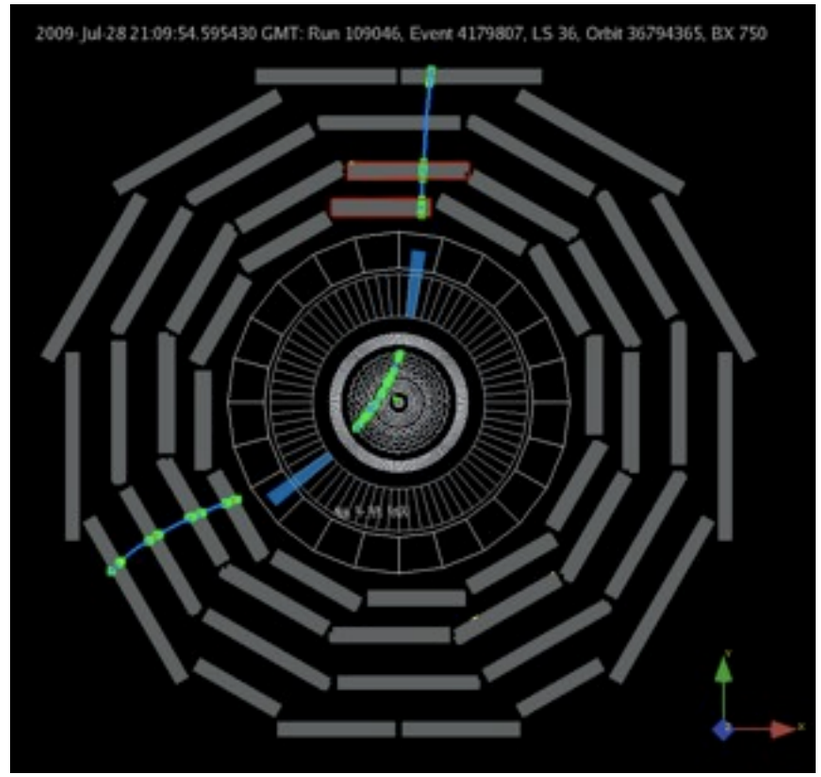
Peak Luminosity : 10^{32} cm^{-2} s^{-1}
Potential performance : 200-300 pb^{-1}

CMS Status

- CMS was closed in July for global running with full magnetic field on CRAFT09 - Cosmic Run At Four Tesla

- Goals of CRAFT09

✓ Collect at least 300 Million triggers with B=3.8T
✓ Include Tracker and Pixel detectors in global runs
✓ Stress test 'final' firmware (for Tracker, Preshower) at highrate
✓ Check tight muon trigger roads – LHC like muon triggers
✓ Extensive run with LHC like Level-1 trigger rates
✓ Commission central Detector Control System > 90% efficiency

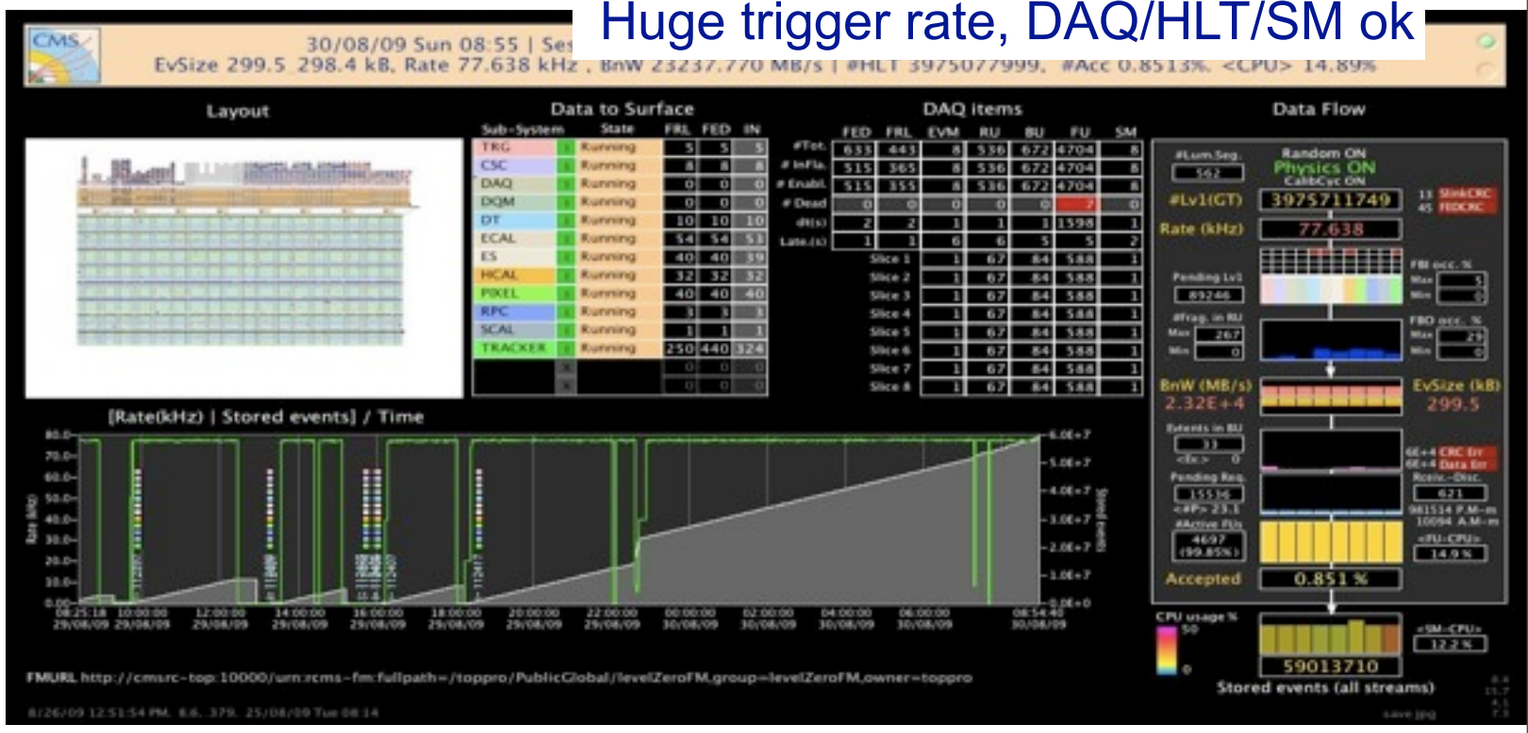


- CRAFT09 is carried out successfully

  - 160 Million Triggers B = 0 T + tracker

  - 320 Million Triggers B =3.8 T + tracker

Huge trigger rate, DAQ/HLT/SM ok



Status of SubDetectors in CRAFT09

- All the subdetectors were operational in the global running.
- Tracker
  - Cooling plants were refurbished before CRAFT09
  - 98% of tracker was alive during CRAFT
  - 100 kHz trigger readout successfully
  - HV trips affected 0.5% of tracker - problem under investigation
  - Pixel detector : 99% Barrel Pixel and 97% Forward Pixel were active
- Electromagnetic Calorimeter (ECAL)
  - Preshower included in global data taking for first time
  - EndCap(+) - Trigger Timing and Control (TCC) boards and Data Concentrator Cards commissioned
- Hadron Calorimeter (HCAL)
  - Barrel, EndCap and Forward calorimeters are in good shape
- Muon Detectors
  - Drift Tubes : Expected performance in CRAFT09 (98% efficiency)
  - Cathode Strip Chambers : 99% operational
  - Resistive Plate Chambers : Fully operational, temperature and current for both barrel and endcap quite stable during full operation

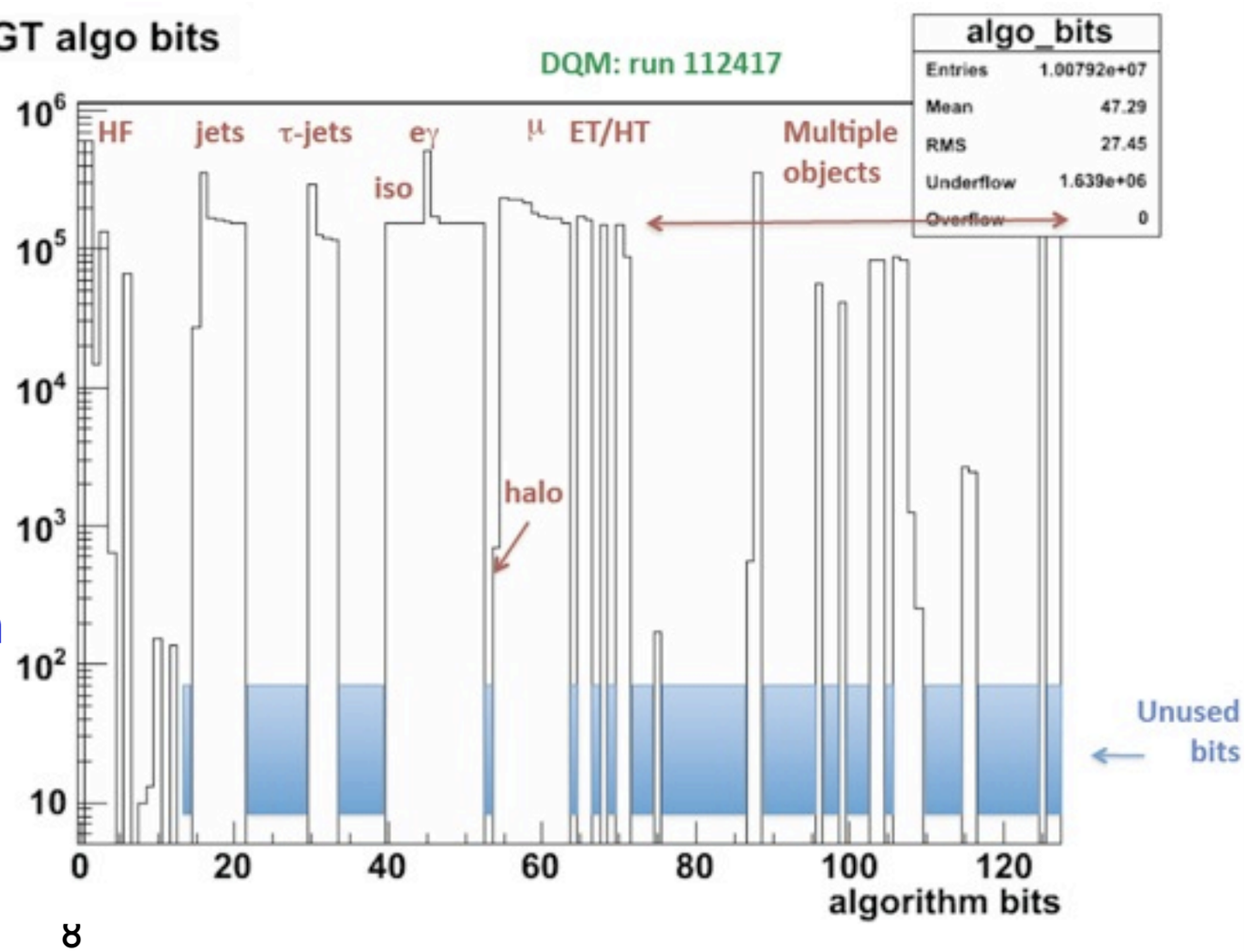
Performance: Dataflow/Trigger

- Performance of Tier 0 : 2.3 billion events processed including all streams with an uptime of 98% (including upgrades and CERN computing downtimes)

- Full offline chain of reconstruction tested including proper input from Alignment-Calibration (AlCa) process with expected latency ~50 hours.

Trigger :

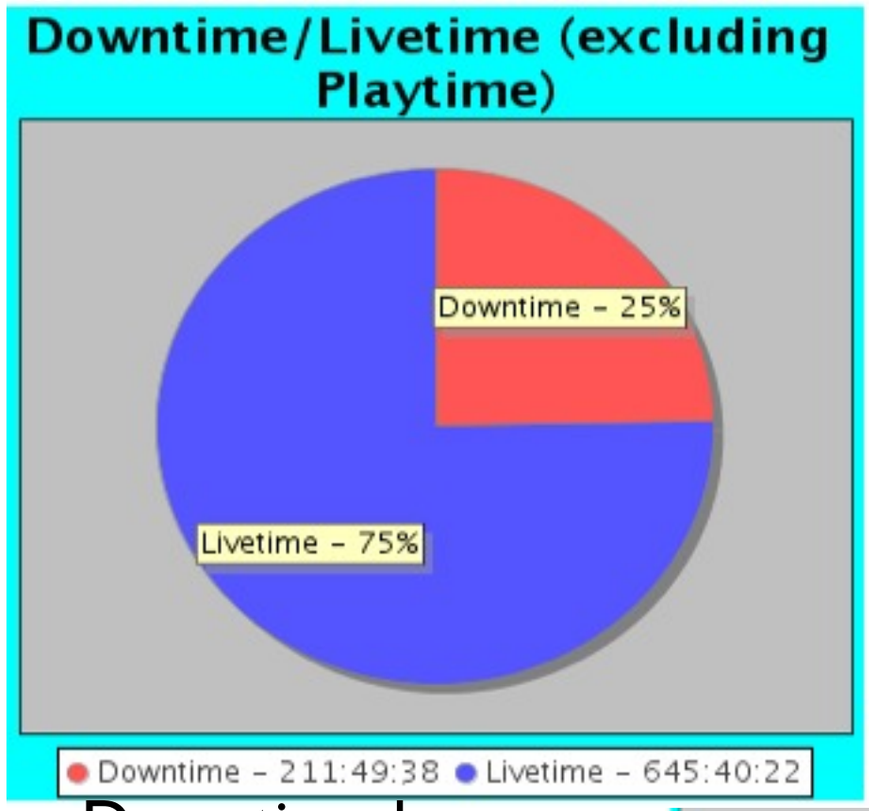
- All Level-1 Trigger algorithms were used in CRAFT09
- ECAL EndCap(+) used for used for Electron Trigger
- Stable rates were observed in CRAFT09 (with some occasional noisy calorimeter towers)

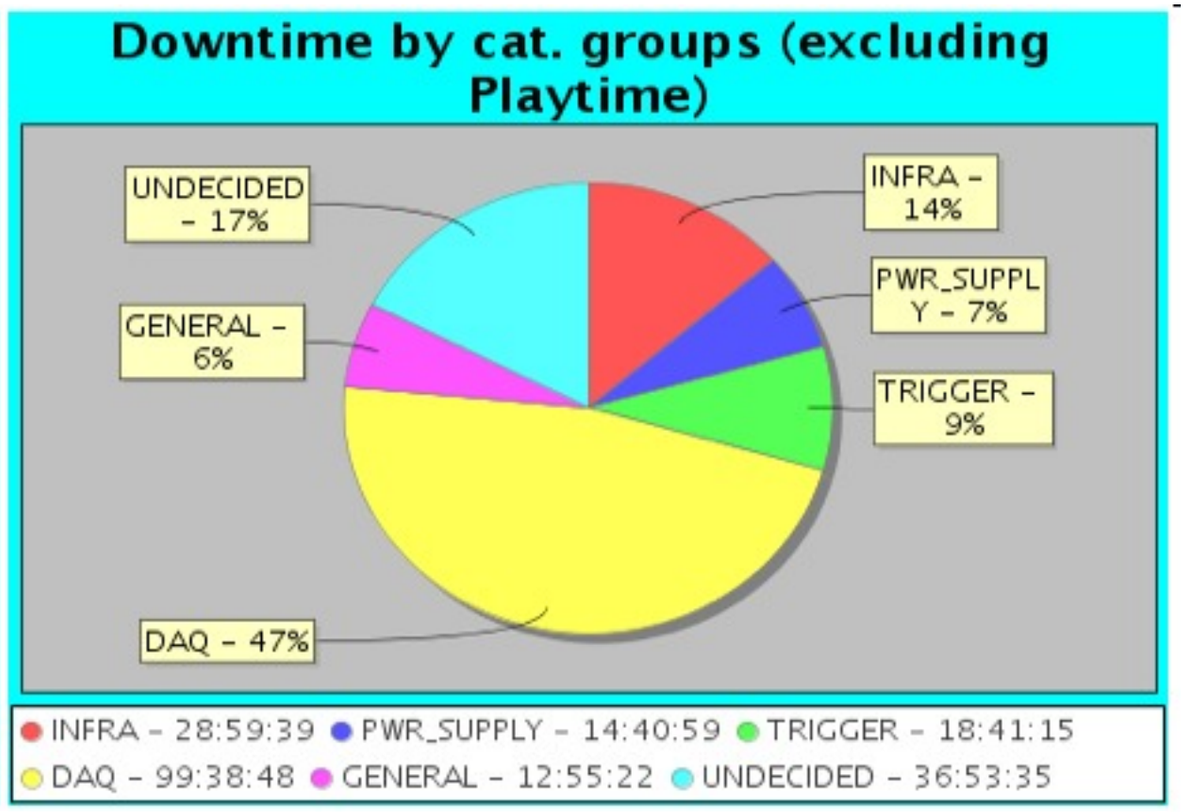


Run Time Logger (RTL)

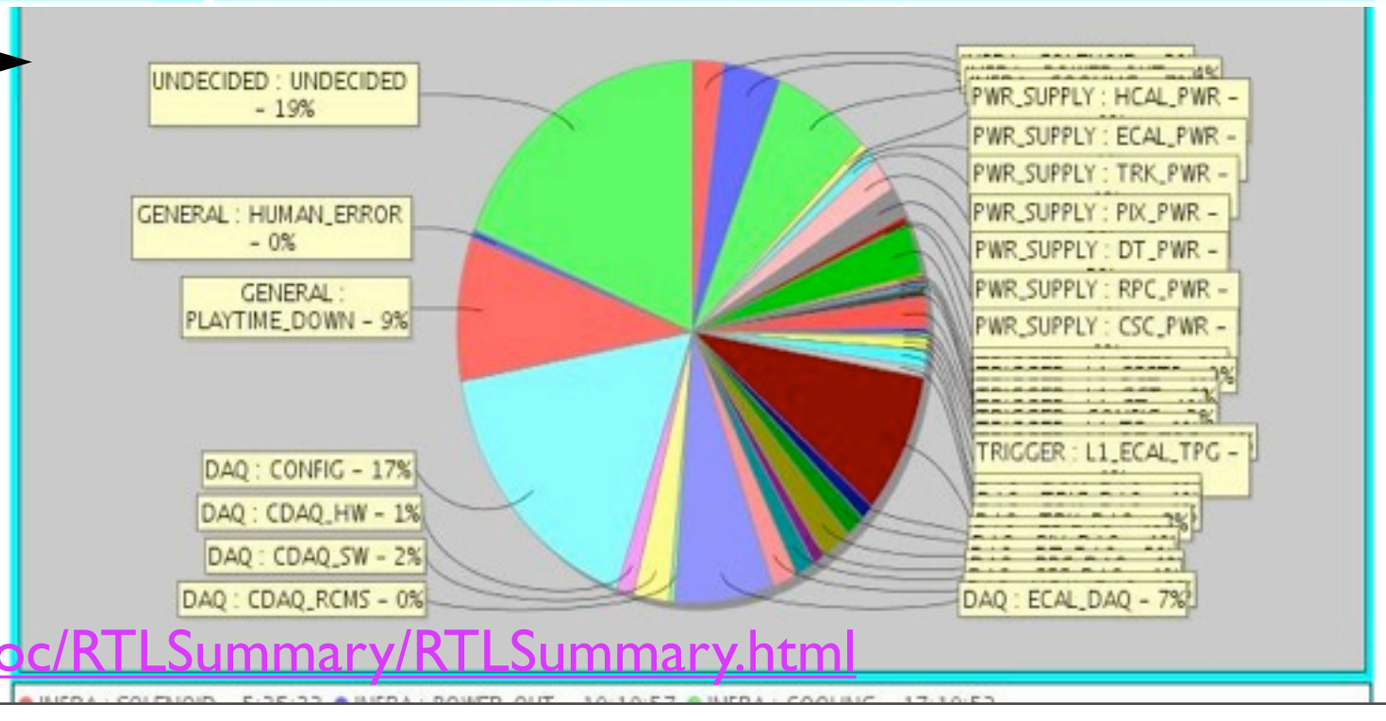
RTL is a tool developed (at Fermilab) to analyze the efficiency of operations at CMS.

Keep track of sources of downtime and identify the sources which have maximum impact on data taking.





Downtime by categories

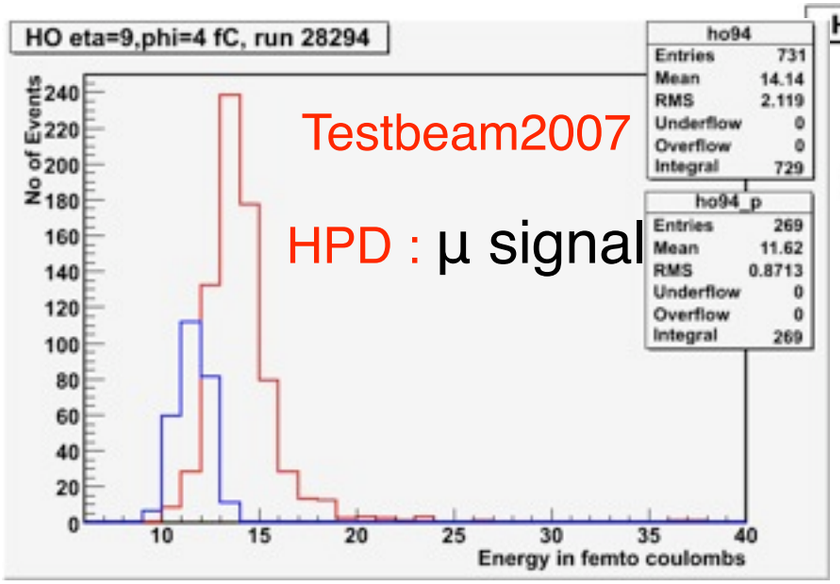


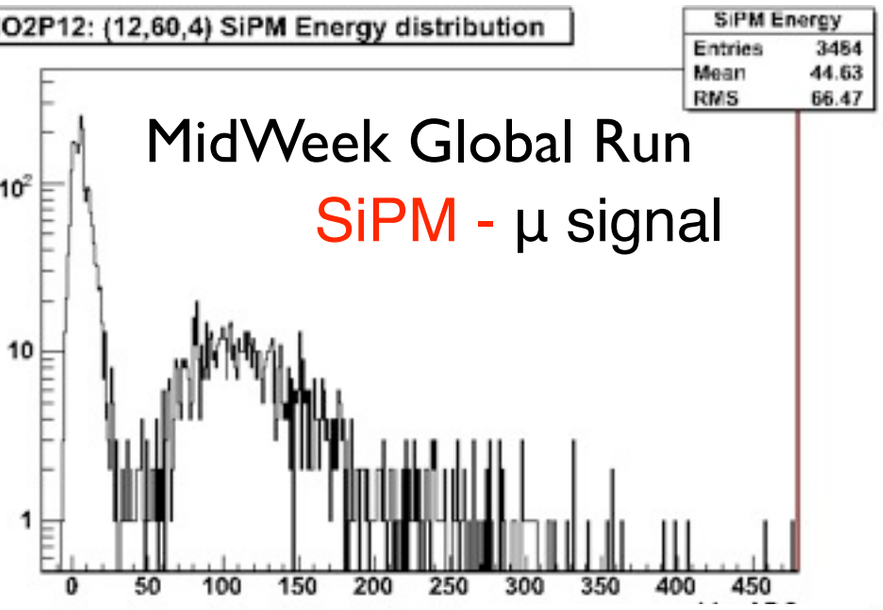
RTL is commissioned and used extensively to understand downtimes during CRAFT 09.

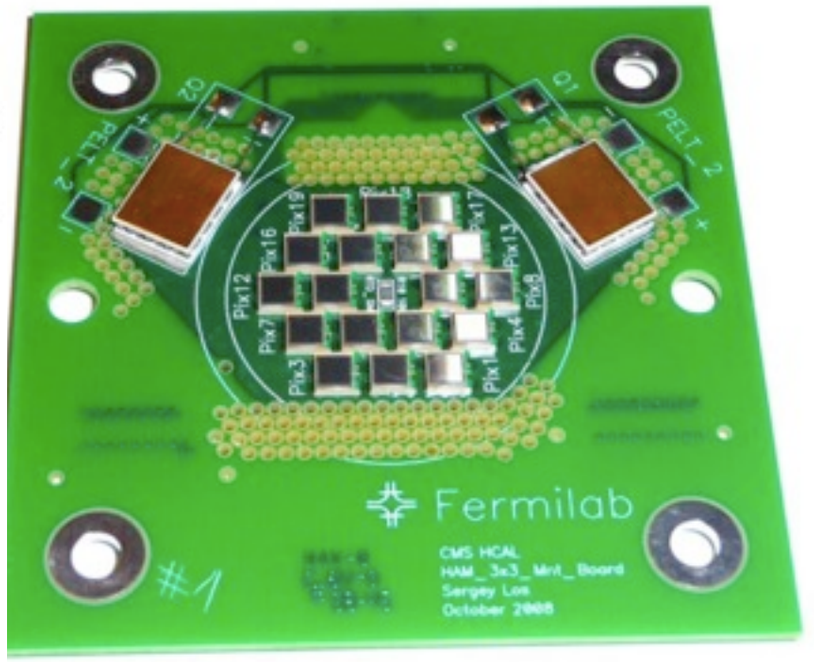
http://www.uscms.org/roc/RTLSummary/RTLSummary.html

Efforts on HCAL Upgrade

Photodetectors used for HCAL Barrel, EndCap and Outer : Hybrid Photo Diodes (HPD)
Possible upgrade to Silicon PhotoMultiplier (SiPM)
Prototype SiPM are tested with Outer HCAL towers.



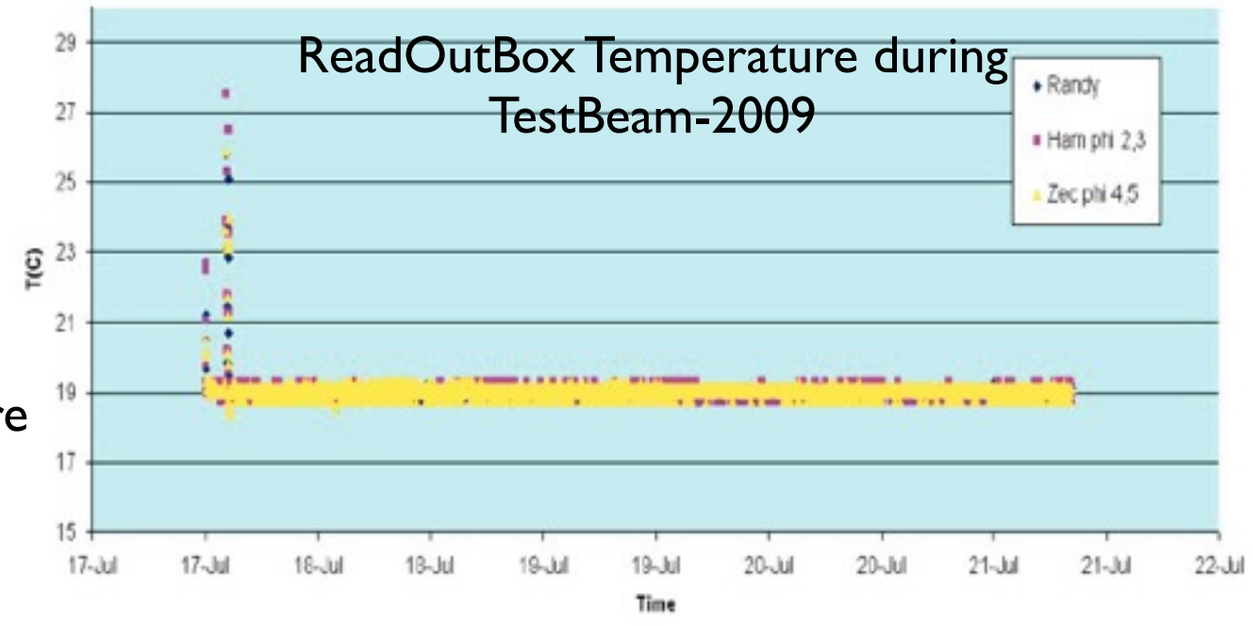




HO RBX temperatures during TB2009

- Excellent S/N and no effect of magnetic field
- Significant progress on temperature stabilization - tested during Testbeam 2009

Temperature stability 0.2˚C (external temperature varied nearly 8 ˚C over the testing period)



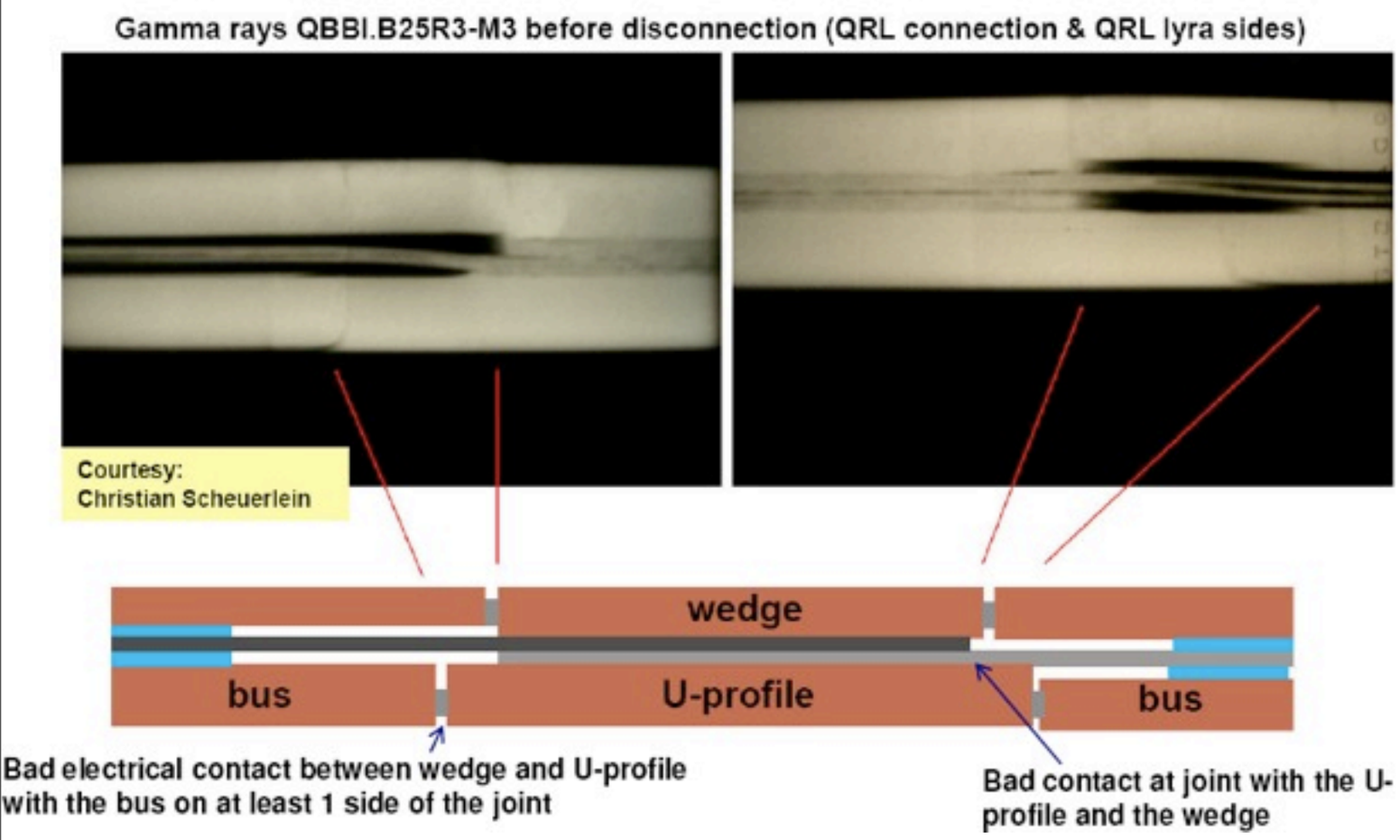
Summary

- It is decided to start LHC with 3.5 TeV and possible constraints are enumerated.
- LHC is well into cool-down phase and is ON schedule for mid-November beam startup. Expecting to have first high energy collisions before Christmas.
- CMS detector successfully finishes global running with cosmics (CRAFT09) with all the subdetectors functioning properly.
- Express data stream, Alignment-Calibration data streams and full reconstruction chain with prompt calibration are exercised during CRAFT09.
- CMS is ready to get into beam commissioning phase.
- Efforts for upgrade are on the way and there is already a significant progress towards upgrade of HCAL photodetectors to SiPMs.

BackUp

Copper Stabilizer problem

Bad surprise after gamma-ray imaging of joints :Void is present in most of the bus extremities because SnAg flew out during soldering of the joint.



- Measurements done in 6 sectors, missing 7-8 and 8-1
- 10 dipole (> 35 μΩ) and 10 quadrupole (> 80 μΩ) joints repaired
- Lot of effort has gone into modeling the problem…

- Case 1 - Joint quenches in 1.9 K environment (within 1 sec from start of the current decay). QPS triggers because magnet reaches 100 mV or bus reached 3 mV-s. Worst scenario - quench happens without cooling Helium.
- Case 2 - Joint quenches in gaseous warm He environment (after time tJQ from the start of quench)

3.5 TeV limits

Ralph Assmann
Werner Herr

Parameter	Limit	Reason(s)
Beam Intensity	~6 e13	collimation cleaning efficiency
□* - crossing angle off	1 m	aperture
□* - with crossing angle	2 – 3 m	aperture, long range beam-beam
Crossing angle [50 ns]	~300 µrad	□*, aperture, long range beam-beam
Peak luminosity	~1 e32	

Given these constraints what can we do?

- Fill length: 8 hours
- Turnaround time: 5 hours
- 20 hours luminosity lifetime
- 30 day months.
- 40% machine availability
- Nominal crossing angle assumed for 50 ns.
- Nominal transverse emittance
- Total intensity limited to around 12% of nominal
- No squeeze beyond 2 m. with 156 bunches, crossing angle off - conservative

Plugging in the numbers – 3.5 TeV

Month	OP scenario	Max number bunch	Protons per bunch	Min beta*	Peak Lumi	Integrated	% nominal	events/X
1	Beam commissioning							
2	Pilot physics combined with commissioning	43	3×10^{10}	4	8.6×10^{29}	~200 nb^{-1}		
3		43	5×10^{10}	4	2.4×10^{30}	~1 pb^{-1}		
4		156	5×10^{10}	2	1.7×10^{31}	~9 pb^{-1}	2.5	
5a	No crossing angle	156	7×10^{10}	2	3.4×10^{31}	~18 pb^{-1}	3.4	
5b	No crossing angle – pushing bunch intensity	156	1×10^{11}	2	6.9×10^{31}	~36 pb^{-1}	4.8	1.6
6	partial 50 ns – nominal crossing angle	144	7×10^{10}	2-3	3.1×10^{31}	~16 pb^{-1}	3.1	0.8
7		288	7×10^{10}	2-3	8.6×10^{31}	~32 pb^{-1}	6.2	
8		432	7×10^{10}	2-3	9.2×10^{31}	~48 pb^{-1}	9.4	
9		432	9×10^{10}	2-3	1.5×10^{32}	~80 pb^{-1}	12	
10		432	9×10^{10}	2-3	1.5×10^{32}	~80 pb^{-1}	12	
11		432	9×10^{10}	2-3	1.5×10^{32}	~80 pb^{-1}	12	

Plugging in the numbers with a step in energy

Month	OP scenario	Max number bunch	Protons per bunch	Min beta*	Peak Lumi	Integrated	% nominal
1	Beam commissioning						
2	Pilot physics combined with commissioning	43	3×10^{10}	4	8.6×10^{29}	~200 nb^{-1}	
3		43	5×10^{10}	4	2.4×10^{30}	~1 pb^{-1}	
4		156	5×10^{10}	2	1.7×10^{31}	~9 pb^{-1}	2.5
5a	No crossing angle	156	7×10^{10}	2	3.4×10^{31}	~18 pb^{-1}	3.4
5b	No crossing angle – pushing bunch intensity	156	1×10^{11}	2	6.9×10^{31}	~36 pb^{-1}	4.8
6	Shift to higher energy: approx 4 weeks	Would aim for physics without crossing angle in the first instance with a gentle ramp back up in intensity					
7	4 – 5 TeV (5 TeV luminosity numbers quoted)	156	7×10^{10}	2	4.9×10^{31}	~26 pb^{-1}	3.4
8	50 ns – nominal Xing angle	144	7×10^{10}	2	4.4×10^{31}	~23 pb^{-1}	3.1
9	50 ns	288	7×10^{10}	2	8.8×10^{31}	~46 pb^{-1}	6.2
10	50 ns	432	7×10^{10}	2	1.3×10^{32}	~69 pb^{-1}	9.4
11	50 ns	432	9×10^{10}	2	2.1×10^{32}	~110 pb^{-1}	12

Runtime Logger Reporting Tool